Geographic distribution of gobies (Gobiidae) in the Adriatic Sea with thirteen new records for its southern part

by

Marcelo KOVAČIĆ* (1), Radek ŠANDA (2), Marin KIRINČIĆ (1)
& Davor ZANELLA (3)

ABSTRACT. - Prior to the present study, the gobiid biodiversity of the Adriatic Sea varied significantly between the northern (98% of the known Adriatic gobiid biodiversity) and central (89%) as compared to the southern Adriatic Sea (39%). Thirteen species are newly recorded for the southern Adriatic area and one for the central Adriatic. The relatively small collecting effort in this survey produced a large increase in the known gobiid biodiversity, which suggests that the low number of known Adriatic gobiid species in the southern Adriatic mirrors only sampling intensity and not the real species richness of the area. The gobiid zoogeography in the Adriatic is compared with that of the Mediterranean.

RÉSUMÉ. - Distribution géographique des gobies (Gobiidae) en mer Adriatique, avec 13 nouveaux signalements dans sa partie méridionale.

Antérieurement à cette étude, la biodiversité des Gobiidés de la mer Adriatique variait significativement entre le nord (98% de la biodiversité des Gobiidés connus de l'Adriatique), le centre (89%) et le sud (39%). Treize espèces sont signalées ici comme nouvelles pour le sud et une pour le centre. Un effort de collecte relativement léger contribue ainsi à une augmentation significative de la biodiversité des Gobiidés, ce qui signifie que le petit nombre d'espèces connu à ce jour dans la partie méridionale de l'Adriatique n'est que le reflet de l'effort d'échantillonnage, et non la réalité de la diversité spécifique dans cette zone. La zoogéographie des Gobiidés en Adriatique est comparée à celle de la Méditerranée.

Key words. - Gobiidae - Adriatic Sea - Zoogeography - New records.

With almost 2000 species, gobies (Gobiidae, Perciformes) are among the most diverse fish families worldwide (Nelson, 2006). With 60 species, they are also the most diverse fish taxon in the Mediterranean Sea (Ahnelt and Dorda, 2004; Kovačić and Patzner, 2011). Most Mediterranean gobies are small benthic species, with a considerable number of strictly cryptobenthic taxa (Miller, 1986). This, together with their small size makes gobies generally difficult to collect with standard fisheries methods. To receive appropriate data on the goby diversity in a given area, specific techniques are necessary, such as using anaesthetics during SCUBA diving. For this reason, the knowledge on the distribution of gobies in the Mediterranean Sea is highly disproportional. Kovačić and Patzner (2011) summarized the data on the zoogeography of Mediterranean gobies, dividing the Mediterranean into six major areas. Pronounced differences in species richness were noticed among the areas, e.g. the Adriatic Sea has 46 gobiid species recorded as opposed to the south-western Mediterranean with just 10 species recorded to date. However, the scarcity of data offers no positive conclusions for the reasons behind these differences. Furthermore, no studies have been carried out on the difference of gobiid biodiversity within any of these Mediterranean areas, likely due to the lack of data, i.e. to the rare distribution of published gobiid records for most Mediterranean gobiid species.

The Adriatic Sea is the smallest of the Mediterranean areas reviewed for Mediterranean gobiid zoogeography by Kovačić and Patzner (2011) and the best researched considering the long history of gobiid studies and efforts by various researchers (see Kovačić, 2005). The checklist of the gobies of the Adriatic Sea, listing 46 species, was published after a period of intensive new species descriptions and new gobiid records in the Adriatic Sea (Kovačić, 2005). This checklist was the result of the compilation and critical re-examination of all available data. The established Adriatic gobiid biodiversity has remained unchanged until the present (Lipej and Dulčić, 2010). The usual zoogeographic division of the Adriatic Sea into the northern, central and southern Adriatic Sea is based on the differences in the ichthyological biodiversities (Jardas, 1996) and benthic biocenologies

---

(1) Prirodoslovni muzej Rijeka, Lorenzov prolaz 1, HR-51000 Rijeka, Croatia.
(2) Department of Zoology, National Museum, Václavské náměsti 68, CZ-115 79 Prague, Czech Republic. [RSanda@seznam.cz]
(3) Department of Zoology, Faculty of Science, University of Zagreb, Rooseveltov trg 6, 10 000 Zagreb, Croatia. [davor.zanella@zg.t-com.hr]
* Corresponding author [marcelo@prirodoslovni.com]

Cybium 2012, 36(3): 435-445.

(Pérès and Gamulin-Brida, 1973). Similar to the Mediterranean Sea differences, the difference in goby diversity in the Adriatic Sea between these units is striking, particularly the low number of species recorded in the southern Adriatic (Kovačić, 2005).

The aims of the present study were to report numerous new records of gobies from the southern Adriatic and a single new record for the central Adriatic, to examine the geographical distribution of gobies within the Adriatic Sea, and to compare the gobiid zoogeography in the Adriatic with that of the Mediterranean.

MATERIAL AND METHODS

The Adriatic Sea is usually zoogeographically divided into the northern Adriatic Sea, as the area north from the line Cape Conero (Italy, south to Ancona) - Karlobag (Croatia), central Adriatic Sea from the above line to the line Cape Gargano (Italy) - tip of the Pelješac Peninsula (Croatia), and the southern Adriatic Sea, the area between the line Cape Gargano (Italy) - tip of the Pelješac Peninsula (Croatia) and the Adriatic border with the Ionian Sea, i.e. line Otranto (Italy) - tip of the Karaburn Peninsula (Albania, west of Vlorë) (Fig. 1) (Pérès and Gamulin-Brida, 1973; Jardas, 1996; Dulčić and Dragičević, 2011). The samples of the new records were collected in June 2004, June 2005, September 2007, August 2010, August 2011 and September 2011 in the southern Adriatic Sea by the authors (Fig. 1). All localities are located in Croatia, with the exception of Jaz Beach near Budva (Montenegro). All fish were collected during SCUBA dives using a hand net and anaesthetic Quinaldine or by hand net only. All collected specimens were euthanized by over-anaesthetization with Quinaldine and preserved in 4% formaldehyde or 96% ethanol. The examined material is deposited in the Natural History Museum Rijeka (PMR) and in the National Museum, Prague (NMP). All specimens were determined in the laboratory. The diagnoses are a minimum combination of characters that positively identify the collected specimens among species of the family Gobiidae in the CLOFNAM area (Miller, 1986; Ahnelt and Dorda, 2004; Kovačić, 2005; 2008 and references therein). Morphometric and meristic methods follow Miller (1988). Terminology of the lateral-line system follows Sanzo (1911) and Miller (1986). A single new record from the central Adriatic Sea was identified from underwater photos shot by Adam Petrusek, thanks to the species coloration characters which were sufficient for unambiguous species diagnosis.

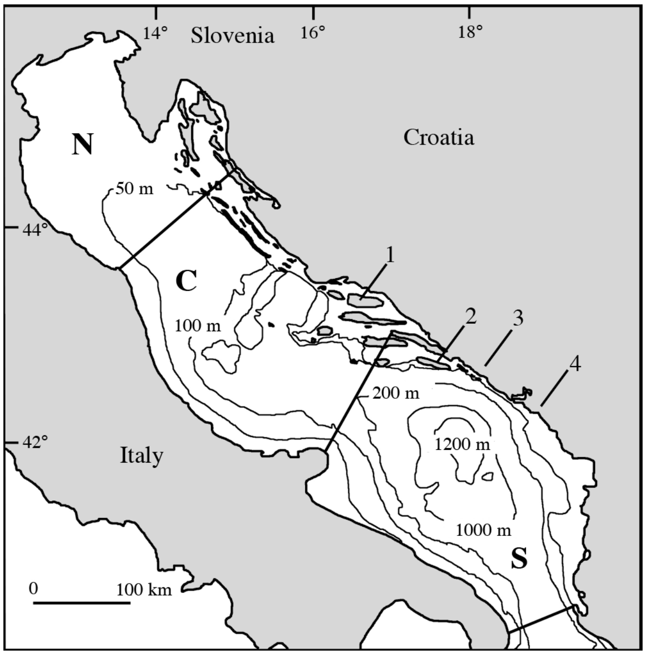

Figure 1. - Map of the Adriatic Sea with the zoogeographic areas. N: northern Adriatic Sea; C: central Adriatic Sea; S; southern Adriatic Sea. The sampling areas of the new records. 1: Brač Island; 2: Mljet Island: 3: Dubrovnik area; 4: Budva.

RESULTS

The list of the species recorded for each of the Adriatic Sea areas is provided in table I, and the details of each record are given in the results below. Thirteen species were newly recorded for the southern Adriatic area and one for the central Adriatic. The four sampling areas are marked in figure 1.

New records from the southern Adriatic

Buenia affinis Iljin, 1930

Material examined

One juvenile of unidentified sex, 11.2 + 3.3 mm, PMR VP1516, Soline Bay, Mljet Island, southern Adriatic Sea, 20 Jun. 2005, coll. M. Kovačić.

Diagnosis

(1) Suborbital papillae of lateral-line system with longitudinal row *a*; (2) pelvic disc with anterior transverse membrane; (3) head canals present without numerous extra pores; (4) suborbital transverse rows absent; (5) pectoral fin count 15 (the known range of pectoral fin count of *B. affinis* is 15-16).

Ecological data

The specimen was found at a shell debris bottom at 1.5 m depth.

Remarks

B. affinis is a small Mediterranean epibenthic gobiid

Table I. - Gobiid diversity in the Adriatic Sea areas based on published data and new records. The details of each new record are given in the "Results".

Species	North Adriatic	Central Adriatic	South Adriatic
Aphia minuta mediterranea De Buen, 1931	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Buenia affinis Iljin, 1930	Kovačić, 2005	Kovačić, 2005	New record
Chromogobius quadrivittatus (Steindachner, 1863)	Kovačić, 2005	Kovačić, 2005	–
Chromogobius zebratus (Kolombatović,1891)	Kovačić, 2005	Kovačić, 2005	New record
Corcyrogobius liechtensteini (Kolombatović, 1891)	Kovačić, 2005	Kovačić, 2005	New record
Crystallogobius linearis (Von Duben, 1845)	Kovačić, 2005	Kovačić, 2005	–
Deltentosteus colonianus (Risso, 1826)	Kovačić, 2005	Kovačić, 2005	–
Deltentosteus quadrimaculatus (Valenciennes, 1837)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Didogobius schlieweni Miller, 1992	Kovačić, 2005	Kovačić, 2005	–
Didogobius splechtnai Ahnelt & Patzner, 1995	Kovačić, 2005	–	New record
Gammogobius steinitzi Bath, 1971	Kovačić, 2005	Debelius, 2001	–
Gobius ater Bellotti, 1888	–	Kovačić, 2005	–
Gobius auratus Risso, 1810	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius bucchichi Steindachner, 1870	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius cobitis Pallas, 1811	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius couchi Miller & El-Tawil, 1974	Kovačić, 2005	Kovačić, 2005	New record
Gobius cruentatus Gmelin, 1789	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius fallax Sarato, 1889	Kovačić, 2005	Kovačić, 2005	New record
Gobius geniporus Valenciennes, 1837	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius kolombatovici Kovačič & Miller, 2000	Kovačić, 2005	–	–
Gobius niger Linnaeus, 1758	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius paganellus Linnaeus, 1758	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Gobius roulei De Buen, 1928	Kovačić, 2005	Kovačić, 2005	New record
Gobius vittatus Vinciguerra, 1883	Kovačić, 2005	Kovačić, 2005	New record
Knipowitschia caucasica (Kawrajsky, 1916)	Kovačić, 2005	Kovačić, 2005	–
Knipowitschia panizzae (Verga, 1841)	Kovačić, 2005	Kovačić, 2005	–
Lebetus guilleti (Le Danois, 1913)	Kovačić, 2005	–	–
Lesueurigobius friesii (Malm, 1874)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Lesueurigobius suerii (Risso, 1810)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Millerigobius macrocephalus (Kolombatović, 1891)	Kovačić, 2005	Kovačić, 2005	New record
Odondebuenia balearica (Pellegrin & Fage, 1907)	Kovačić, 2005	Kovačić, 2005	New record
Pomatoschistus bathi Miller, 1982	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Pomatoschistus canestrinii (Ninni, 1883)	Kovačić, 2005	Kovačić, 2005	–
Pomatoschistus knerii (Steindachner, 1861)	Kovačić, 2005	Kovačić, 2005	–
Pomatoschistus marmoratus (Risso, 1810)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Pomatoschistus minutus (Pallas, 1770)	Kovačić, 2005	Kovačić, 2005	–
Pomatoschistus norvegicus (Collett, 1903)	Kovačić, 2005	–	New record
Pomatoschistus pictus (Malm, 1865)	Kovačić, 2005	Kovačić, 2005	–
Pomatoschistus quagga (Heckel, 1840)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Pseudaphya ferreri (De Buen & Fage, 1908)	Kovačić, 2005	Kovačić, 2005	New record
Speleogobius trigloides (Zander & Jelinek, 1976)	Kovačić, 2005	Kovačić, 2005	–
Thorogobius ephippiatus (Lowe, 1839)	Kovačić, 2005	New record	Kovačić, 2005

Table I. - Continued.

Species	North Adriatic	Central Adriatic	South Adriatic
Thorogobius macrolepis (Kolombatović, 1891)	Kovačić, 2005	Kovačić, 2005	Guidetti *et al.*, 2006
Vanneaugobius dollfusi (Briwnell, 1978)	Kovačić, 2008	Kovačić, 2005	Kovačić, 2005
Zebrus zebrus (Risso, 1826)	Kovačić, 2005	Kovačić, 2005	New record
Zosterisessor ophiocephalus (Pallas, 1811)	Kovačić, 2005	Kovačić, 2005	Kovačić, 2005
Sum of published records of gobies	45	41	18
Sum of new records of gobies	0	1	13
Total number of known gobiid species for area	45	42	31
Percentage of Adriatic gobiid biodiversity	97.8%	91.3%	67.4%

species with confirmed records only from Banyuls-sur-Mer (France) and Naples (Italy) in the north-western Mediterranean and from the Adriatic Sea (Kovačić and Patzner, 2009). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea. The only published record in the central Adriatic Sea from Seline (Velebit Channel) is near the borderline (following the Adriatic zoogeographic division cited in Material and Methods) between the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005). However, the species likely has a wider distribution in the central Adriatic. One specimen of *B. affinis* (voucher NMP P6V 87547) was collected at Sumartin, Brač Island (43°17'21.60"N; 16°52'40.5"E), in the southern part of the central Adriatic area.

Chromogobius zebratus (Kolombatović, 1891)

Material examined

Two males, 33.9 + 8.4 mm and 34.1 +7 .5 mm, PMR VP2757; 1 female, 30.3 + 7.3 mm and one juvenile of unidentified sex, 22.4 + 5.5 mm, PMR VP2788; Daksa Island, Dubrovnik, southern Adriatic Sea (42°39'58.2''N; 18°03'24.5''E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular and preopercular canals present, posterior oculoscapular canal absent; (3) pelvic fins forming disc; (4) interorbital papillae absent; (5) transverse suborbital rows 7; (6) scales in lateral series 43-49 (the known range of scales in lateral series of *C. zebratus* is 41-52).

Ecological data

The specimens were hidden among boulders, gravel and cobbles at 3-10 m depth.

Remarks

C. zebratus is a small Mediterranean cryptobenthic gobiid species known from Cádiz Bay on the Atlantic coast near the Strait of Gibraltar to Arsuz in Turkey, near the easternmost point of the Mediterranean Sea (Kovačić *et al.*, 2011). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Corcyrogobius liechtensteini (Kolombatović, 1891)

Material examined

One juvenile of unidentified sex, 7.5 + 2.0 mm, PMR VP2753, Grebeni Islet, Dubrovnik, southern Adriatic Sea (42°39'6.7''N; 18°02'53.4''E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; one juvenile of unidentified sex, 8.7 + 2.1 mm, PMR VP2790, Daksa Island, Dubrovnik, southern Adriatic Sea (42°39'58.2''N; 18°03'24.5''E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular canal present, posterior oculoscapular and preopercular canals absent; (3) caudal fin rounded; (4) transverse suborbital rows 6 (last row with 1 papilla).

Ecological data

Two specimens were collected at two proximal locations in the Dubrovnik area. At the locality Grebeni, the specimen was hidden among boulders and cobbles at 10 m depth. At the locality Daksa, the specimen was hidden in the crevice of a large rock at a depth of 5 m.

Remarks

C. liechtensteini is a small Mediterranean cryptobenthic gobiid species known from a few findings in the north-western Mediterranean, Adriatic Sea and a recent find at Crete (Kovačić *et al.,* 2011). In the Adriatic Sea the species was previously recorded in the northern and central Adriatic Sea, with the southernmost record at Korčula Island, on the border between the central and south Adriatic Sea (Tab. I) (Kovačić, 2005).

Didogobius splechtnai **Ahnelt & Patzner, 1995**

Material examined

One female, 16.6 + 4.4 mm, PMR VP2783, the beach between Slano and Trsteno, Dubrovnik, southern Adriatic Sea (42°37'10.7''N; 18°11'28.8''E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular and preopercular canals present, posterior oculoscapular canal absent; (3) pelvic fins forming disc; (4) interorbital papillae absent; (5) transverse suborbital rows 6 (last row with 1 papilla); (6) scales in lateral series 29 (the known species range of scales in lateral series is 28-30).

Ecological data

The specimen was hidden in a small cave in steep bedrock at 18 m depth.

Remarks

D. splechtnai is a small Mediterranean cryptobenthic gobiid species known from a few findings in the north-western Mediterranean and central Mediterranean i.e. Lampedusa Island (Italy) and the Adriatic Sea (Francour, 2008). In the Adriatic Sea, the species was previously recorded only in the northern Adriatic Sea (Tab. I) (Kovačić, 2005).

Gobius couchi **Miller & El-Tawil, 1974**

Material examined

Three juveniles of unidentified sex, 17.9 + 4.7 mm to 21.0-5.3 mm, PMR VP2780, beach between Slano and Trsteno, Dubrovnik, southern Adriatic Sea (42°37'10.7''N, 18°11'28.8''E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) predorsal area scaled; (4) anterior oculoscapular canal with pore α at rear of orbit; (5) oculoscapular row x^1 not extending forwards to pore β; (6) scales in lateral series 39-41 (the known species range of scales in lateral series is 35-43); (7) row *d* divided below row *3*; (8) pelvic fin truncated to slightly emarginated, i.e. the shortest branches of the fifth pelvic ray compared to the longest branches of the fourth pelvic ray 88-100% (the known species range of this ratio is 85-100%) (9) pectoral fin count 16-17 (same as the published range of *G. couchi*).

Ecological data

The specimens were found on a sandy bottom with scattered boulders at 8 m depth.

Remarks

G. couchi is a goby known from Atlantic localities in Great Britain and Ireland and from several localities in the north and eastern Mediterranean (Šanda and Kovačić, 2009; Kovačić *et al.,* 2011). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Gobius fallax **Sarato, 1889**

Material examined

One female, 39.7 + 9.5 mm, PMR VP1366, Veliko Jezero, Mljet Island, southern Adriatic Sea, 18 Jun. 2005, coll. M. Kovačić.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) predorsal area scaled; (4) anterior oculoscapular canal with pore α at rear of orbit; (5) oculoscapular row x^1 not extending forwards to pore β; (6) scales in lateral series 43 and 44 (the known species range of scales in lateral series is 40-46); (7) row *d* divided below row *3*; (8) pelvic fin emarginated i.e. the shortest branches of the fifth pelvic ray compared to the longest branches of the fourth pelvic ray 79% (the known species range of this ratio is 65-88%).

Ecological data

The specimen was found on a mixed bottom of boulders, bedrock and sand at 5 m depth.

Remarks

G. fallax is a Mediterranean goby known from the Balearic Islands in the western Mediterranean and along the north coast of the Mediterranean to Cyprus in the east (Kovačić *et al.,* 2011). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Gobius roulei **De Buen, 1928**

Material examined

One male, 42.1 + 8.2 mm, NMP P6V 85748; 1 juvenile of unidentified sex, 34.8 + 5.9 mm; NMP P6V 85749; Cavtat, Dubrovnik, southern Adriatic Sea (42°34'50"N; 18°12'55"E), 15 Sep. 2007, coll. R. Šanda.

4 males, 38.7 + 9.1 mm to 55.6 + 14.6 mm and 1 female, 35.7 + 8.8 mm, PMR VP2747; 1 female, 37.9 + 8.9 mm, 1 male, 45.5 + 89.9 mm and 4 juveniles of unidentified sex, 24.4 + 5.6 to 36.1 + 8.2 mm, PMR VP2775; all at Kupari, Dubrovnik, southern Adriatic Sea (42°37’10.7’’N; 18°11’28.8’’E), 14 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) predorsal area naked; (4) anterior dorsal row *g* ends behind lateral end of row *o*; (5) transverse suborbital rows 6.

Ecological data

This species was collected in the Dubrovnik area at Kupari and Cavtat. At both localities, specimens were found on a sandy bottom with scattered cobbles at 3.5-5 m depth.

Remarks

G. roulei is a goby known off the southern Portugal coast, in the north-western Mediterranean, Adriatic Sea and Cyprus (Liu *et al.,* 2009). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Gobius vittatus **Vinciguerra, 1883**

Material examined

One male, 27.1 + 6.3 mm, PMR VP2784, beach between Slano and Trsteno, Dubrovnik area, southern Adriatic Sea (42°37’10.7’’N; 18°11’28.8’’E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 male, 26.2 + 6.3 mm, and 1 juvenile of unidentified sex, 20.3 +5.3 mm, PMR VP2755, Grebeni Islet, Dubrovnik, southern Adriatic Sea (42°39’6.7’’N; 18°02’53.4’’E), 16 Sep.2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 female, 24.6 + 6.0 mm, PMR VP2789, Daksa Island, Dubrovnik, southern Adriatic Sea (42°39’58.2’’N; 18°03’24.5’’E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) predorsal area scaled; (5) anterior oculoscapular canal with pore α at rear of orbit; (6) oculoscapular row x^1 not extending forwards to pore β; (7) scales in lateral series 32-36 (the known species range of scales in lateral series is also 32-36); (8) black longitudinal band along body and head.

Ecological data

This species was found at three locations in the Dubrovnik area. The specimens were collected at bedrock at 12 and 18 m depth and mixed sandy rocky bottom at 10 m depth.

Remarks

G. vittatus is a small epibenthic Mediterranean goby reported from the Alboran Sea, along the north coast of Mediterranean to the Levant (Kovačić *et al.,* 2011). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Millerigobius macrocephalus **(Kolombatović, 1891)**

Material examined

One male, 25.2 + 7.2 mm, PMR VP1359, Soline Bay, Mljet Island, southern Adriatic Sea, 22 Jun. 2005, coll. M. Kovačić.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular and preopercular canals present, posterior oculoscapular canal absent; (3) pelvic fins forming disc; (4) interorbital papillae present.

Ecological data

The specimen was hidden below boulders and cobbles at about 1.5 m depth.

Remarks

M. macrocephalus is a small Mediterranean cryptobenthic gobiid species known from Mar Menor (Spain) in the west, along the north coast of the Mediterranean to the Levant (Israel) in the east (Vanhove *et al*., 2011). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Odondebuenia balearica **(Pellegrin & Fage, 1907)**

Material examined

One juvenile of unidentified sex, 16.7 + 3.8 mm, NMP P6V 85748, Cavtat, Dubrovnik, southern Adriatic Sea (42°34’50”N; 18°12’55”E), 15 Sep. 2007, coll. R. Šanda; 3 females, 14.9 + 4.1 mm to 15.1 + 4.4 mm, 1 male, 22.8 + 6.0 mm, and 3 juveniles of unidentified sex, 7.4 + 2.5 mm to 12.1 + 3.7 mm, PMR VP2782, beach between Slano and Trsteno, Dubrovnik, southern Adriatic Sea (42°37’10.7’’N; 18°11’28.8’’E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 female, 20.5 + 5.0 mm, 1 male, 20.3 + 5.7 mm, and 2 juveniles of unidentified sex, 11.1 + 3.4 mm and 12.7 + 3.6 mm, PMR VP2756, Daksa Island, Dubrovnik, southern Adriatic Sea (42°39’58.2’’N; 18°03’24.5’’E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular and preopercular canals present, posterior oculoscapular canal absent; (3) pelvic fins almost separate; (4) transverse suborbital rows 6 (last row with 1 papilla).

Ecological data

The specimens in the Dubrovnik area were collected at three locations, the beach between Slano and Trsteno, Daksa Island and Cavtat. At the locality between Slano and Trsteno, the specimens were hidden in *Cystoseira* sp. at 20-23 m depth. At the locality Daksa, the specimens were hidden below boulders on sand at 15 m depth. At the locality Cavtat, the specimen was found on a free sandy bottom between *Posidonia* seagrass hidden in a shell of *Tona galea*.

Remarks

O. balearica is a small cryptobenthic Mediterranean goby known from the Balearic Islands in the west, along the north coast of Mediterranean to Cyprus in the east (Kovačić and Golani, 2007). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Pomatoschistus norvegicus **(Collett, 1903)**

Material examined

One male, 26.3 + 5.4 mm, PMR VP1849, mouth of the Ombla River, Dubrovnik, southern Adriatic Sea, 21 Jun. 2004, coll. M. Kovačić.

Diagnosis

(1) Suborbital papillae of lateral-line system with longitudinal row *a*; (2) pelvic disc with anterior transverse membrane; (3) head canals present without numerous extra pores; (4) several suborbital transverse rows *c* present; (5) anterior oculoscapular canal extends on to snout, to pores σ; (6) scales in lateral series 55 and 57 (the known species range of scales in lateral series is 55-60); (7) suborbital row *b* ending anteriorly below posterior half of eye; (8) pectoral fin count 17 (the known range of pectoral fin count of *P. norvegicus* is 16-18).

Ecological data

This species was collected at the mouth of the Ombla River in the Dubrovnik area. The Ombla River is just 30 m long and is divided from the sea by a waterfall less than 1 m high. The specimen was found in the transitional waters below the waterfall, on a mixed bottom of gravel, sand and cobbles at 6 m depth.

Remarks

P. norvegicus is a small goby known from the Atlantic localities in Great Britain, Ireland and Norway. Three old records from the Mediterranean are known from off of Malaga (Spain), the Gulf of Gaeta in the Tyrrhenian Sea (Italy) and Gulf of Aegina in the Aegean Sea (Greece) (Stefanni, 2000). In 1995, it was recorded in Banyuls-sur-Mer, southern France (Ahnelt and Dorda, 2004). In the Adriatic Sea, the species was previously recorded only in the northern Adriatic Sea by Stefanni (2000) (Tab. I) (Kovačić, 2005). This species typically inhabits deeper waters (Miller, 1986). However, the records from Adriatic Sea (Stefanni, 2000 and the new record from Dubrovnik) are both from rather shallow waters.

Pseudaphya ferreri **(De Buen & Fage, 1908)**

Material examined

Three females, 14.3 + 2.5 mm to 18.7 + 4.0 mm, and 1 male, 18.6 +3.8 mm, PMR VP1362, Veliko Jezero, Mljet Island, southern Adriatic Sea, 18 June 2005, coll. M. Kovačić.

Diagnosis

(1) Suborbital papillae of lateral-line system with longitudinal row *a*; (2) pelvic disc with anterior transverse membrane; (3) head canals present without numerous extra pores; (4) several suborbital transverse rows *c* present; (5) anterior oculoscapular canal ends in interorbit, with paired pores λ; (6) caudal fin slightly emarginated.

Ecological data

The specimens were collected at the edge of a large *Cladocora caespitosa* reef at a deeper sandy bottom at 15 m depth. The school was swimming distinctly above the bottom.

Remarks

P. ferreri is a small nektonic goby known in the northwestern Mediterranean and the Adriatic Sea (Miller, 1986). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

Zebrus zebrus **(Risso, 1826)**

Material examined

One juvenile of unidentified sex, 16.2 + 3.2 mm, 26 Aug. 2010 and 1 male, 16.7 + 3.8 mm, NMP P6p 12/2012, Jaz Beach, Budva, Montenegro, 11 Aug. 2011; 2 females, 14.7 + 3.8 mm and 18.9 + 4.1 mm and 1 juvenile of unidentified sex, 11.9 + 3.5 mm, PMR VP2778, Kupari, Dubrovnik, southern Adriatic Sea (42°37’10.7’’N; 18°11’28.8’’E), 14

Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 2 juveniles of unidentified sex, 13.7 + 3.3 mm and 14.7 + 3.8 mm, PMR VP2779, beach between Slano and Trsteno, Dubrovnik, southern Adriatic Sea (42°37'10.7''N; 18°11'28.8''E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 female, 14.5 + 3.8 mm, PMR VP2752, Grebeni Islet, Dubrovnik, southern Adriatic Sea (42°39'6.7''N; 18°02'53.4''E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 female, 19.0 + 4.0 mm, PMR VP2787, Daksa Island, Dubrovnik, southern Adriatic Sea (42°39'58.2''N; 18°03'24.5''E), 16 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) predorsal area naked; (4) anterior dorsal row *g* ends behind lateral end of row *o*; (5) transverse suborbital rows 7.

Ecological data

This species was found at four localities in the Dubrovnik area (Croatia), and near Budva (Montenegro). The specimens were found hidden among cobbles and boulders at 1-6 m depth, cobbles at 1.5 m depth, boulders and gravel at 5 m depth and in small holes in large stones at 2 m depth.

Remarks

Z. zebrus is a small cryptobenthic goby widespread in the Mediterranean and also recently recorded in the Black Sea (Kovačić and Engin, 2009). In the Adriatic Sea, the species was previously recorded in the northern and central Adriatic Sea (Tab. I) (Kovačić, 2005).

New record from the central Adriatic

Thorogobius ephippiatus (Lowe, 1839)

Diagnosis

The head and body whitish with large dark brown blotches.

Geographical data

The specimen was photographed (Fig. 2) at Sumartin, Brač Island (43°17'21.60"N; 16°52'40.5"E) by Adam Petrusek on 12 Sep. 2011.

Remarks

The coloration of this species is unique among species of the Gobiidae family in the CLOFNAM area (Miller, 1986). In the Mediterranean, typical habitats for this species are submarine caves and deep crevices, where it usually occurs lying on soft sediment (Schultz, 1975). *T. ephippiatus* is a widespread goby known from the eastern Atlantic and northern Mediterranean, with the easternmost record in the Aegean Sea (Miller, 1986) and the southernmost Mediterranean record at Crete (Kovačić *et al.*, 2011). The species was previously recorded in the northern and southern Adriatic Sea (Kovačić, 2005).

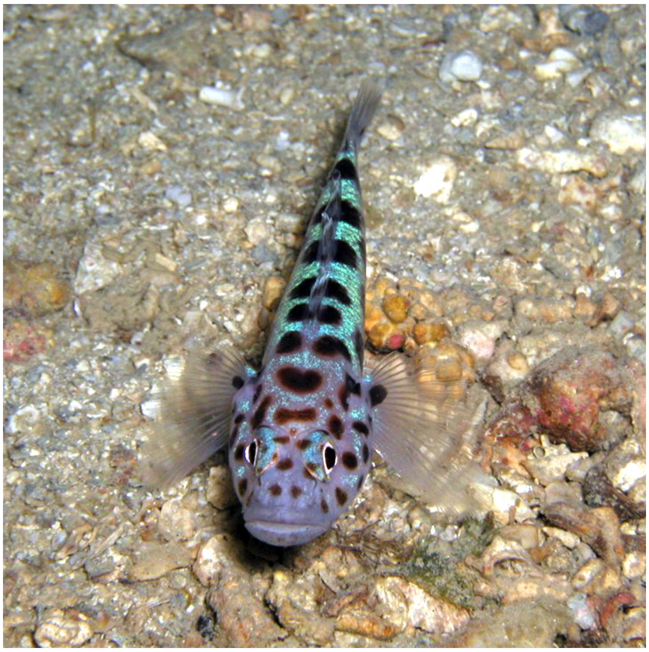

Figure 2. - *Thorogobius ephippiatus*, underwater photograph, Island of Brač, Sumartin (Adam Petrusek).

DISCUSSION

The present fish biodiversity of the Adriatic Sea and its parts is the result of the geological history, geomorphology and environmental (mostly hydrographic) factors in the Adriatic Sea (Jardas, 1996). In the recent past during the last glacial maximum (between 26,500 and 19,000 years ago), the sea level was about 120 m lower (Clark *et al.*, 2009), and the entire area of the present northern Adriatic Sea area was dry. The northern Adriatic Sea today is a shallow sea with depths of less than 100 m, the deepest part of the central Adriatic Sea is the area of the Jabuka Pit (273 m depth), and in the southern Adriatic Sea, the lowest depth in the South-Adriatic Pit reaches 1330 m (Fig. 1). The sea temperature varies throughout the Adriatic Sea, with depth and seasonally. However, the most limiting temperature factor for fish biodiversity is the winter surface minimum, which is about 8°C in the northern Adriatic Sea, much lower than in the rest of the Adriatic Sea (Jardas, 1996). Furthermore, during colder winters, the inshore waters of the northern Adriatic Sea can reach a minimum temperature of as low as 4°C, or even 0°C (Pérès and Gamulin-Brida, 1973). The salinity of the sea water in the Adriatic Sea has a general gradient, diminishing from south to north, and from the open sea towards the coast (Jardas, 1996). This gradient is the result of the influx of more saline eastern Mediterranean water into the Adriatic Sea in the south and the influence of freshwater from the rivers in the north. The Adriatic Sea is considered an oligotrophic sea. However, the northern Adriatic Sea has much higher productivity compared to other Adriatic areas, due to the high nutrient input from the northern Adriatic rivers, lower salinity and shallower depths (Dulčić and Dragičević, 2011). Bottom deposits show general differences among the areas, being typically sandy in the northern Adriatic, silty in the southern Adriatic and of transitional character in the central Adriatic Sea (Jardas, 1996). However, all three areas of the Adriatic Sea have various rocky and sediment habitats available, e.g. the bottom of the channels in the Kvarner area in the eastern part of the dominantly sandy northern Adriatic Sea is mostly silty.

According to Jardas (1996), the northern Adriatic area, more so than the other areas, is characterized by boreal ichthyofauna, the Adriatic endemic species of transitional waters and anadromous Adriatic endemic species. The central Adriatic has mesopelagic, bathypelagic and bathybenthic fishes thanks to its depth, and thermophilic ichthyofauna due to the moderate winter temperatures that are lacking in the northern Adriatic Sea. However, the bathyphilic and thermophilic ichthyofauna are both rich and abundant only in the southern Adriatic Sea. During the past several decades, the number of thermophilic fish species and their abundance has increased in the central and northern Adriatic Sea, following hydrographic changes and the warming of the Adriatic Sea (Dulčić *et al.*, 1999). Considering the young age (present interglacial) of the recent northern Adriatic Sea, the entire ichthyofauna of the northern Adriatic Sea must have originated in other parts of the Adriatic Sea. This includes the northern Adriatic endemic pipefish *Syngnathus taenionotus* Canestrini, 1871, which either originated elsewhere or is the result of the rapid speciation in this area.

The zoogeographic differences in the sea, i.e. geographic changes in biodiversity, are always the result of the sum of the species geographic distributions. Without geographic barriers, the geographic changes in the biodiversity are gradients, and the set borders of the areas are artificial. However, for the purpose of addressing the data on gobiid diversity, the most commonly used delimitation of the Adriatic Sea zoogeographic areas was applied in this paper: the line Ancona (Italy) - Karlobag (Croatia), the line Cape Gargano (Italy) to the tip of the Pelješac Peninsula (Croatia), and the line Otranto (Italy) to the tip of Karaburn Peninsula (Albania, west of Vlorë) (Pérès and Gamulin-Brida, 1973; Jardas, 1996; Dulčić and Dragičević, 2011) (Fig. 1).

Prior to the present results, the known gobiid biodiversity exhibited pronounced differences between the northern (98% of the known Adriatic gobiid biodiversity) and central (89%) as compared to the southern Adriatic Sea (39%) (Tab. I) (Debelius, 2001; Kovačić, 2005; Guidetti *et al.*, 2006). The present study increased the known gobiid biodiversity in the southern Adriatic Sea to 67% of the Adriatic gobiid biodiversity (Tab. I). The relatively small collecting effort of the present study produced a large increase in the known gobiid biodiversity, which suggests that the low number of Adriatic gobiid species known in the southern Adriatic Sea mirrors sampling intensity and not the real species richness. To date, gobiid research has undoubtedly been more intensive in the northern and central Adriatic Sea (Kovačić, 2005).

A single species not recorded for the northern Adriatic Sea is *Gobius ater* Bellotti, 1888, which is generally a rarely recorded species and its habitat is still not well described (according to Miller, 1986: inshore lagoons, among sea grass). SCUBA diving and the anaesthetic technique can hardly be successfully applied with this species. All four Adriatic gobiid species yet not recorded for the central Adriatic Sea (Tab. I) were recorded for the first time in the northern Adriatic Sea during the period 2000-2002 (Kovačić, 2005). For three species (excluding *P. norvegicus*, for which habitat preferences in the Mediterranean are still unclear), a greater research intensity using SCUBA diving/anaesthetic technique in their specific habitats should provide an answer regarding their presence in the central Adriatic Sea.

The fifteen Adriatic gobiid species yet unrecorded in the southern Adriatic Sea could be grouped by their species abundance in the Adriatic Sea and the Mediterranean, by the level of knowledge on their habitat preferences, by the abundance of their preferred habitats in the Adriatic Sea and by the most appropriate collection technique:

1) Five species (*Chromogobius quadrivittatus* (Steindachner, 1863); *Didogobius schlieweni* Miller, 1992; *Gammogobius steinitzi* Bath, 1971; *Gobius kolombatovici* Kovačič & Miller, 2000; *Speleogobius trigloides* (Zander & Jelinek, 1976)) have well defined microhabitats on hard bottom or mixed bottoms common in the Adriatic Sea and the SCUBA diving/anaesthetic technique is appropriate for their collection, though some are quite rare and a greater collecting effort is usually required to locate them (Kovačić, 2005 and references therein).

2) Four of the unrecorded species are soft bottom epibenthic species, with microhabitat preferences yet to be well defined, and therefore having rare (*Deltentosteus colonianus* (Risso, 1826), *Lebetus guilleti* (Le Danois, 1913) and *Pomatoschistus minutus* (Pallas, 1770)) or just historical records in the Adriatic Sea (*Pomatoschistus pictus* (Malm, 1865)) (Kovačić, 2005 and references therein).

3) Two *Knipowitschia* species and *Pomatoschistus canestrinii* (Ninni, 1883) are euryhaline fishes that could be present only in brackish and transitional waters where they are quite abundant in some northern and central Adriatic localities (Kovačić, 2005 and the references therein). *P. can-*

estrinii and *K. panizzae* (Verga, 1841) are Adriatic endemic fishes, while the taxonomic status of the Adriatic *K. caucasica* (Kawrajsky, 1916) has recently become questionable (Kovačić, 2008).

4) The hyperbenthic *Pomatoschistus knerii* (Steindachner, 1861) was collected by SCUBA diving in the northern Adriatic Sea, but only in the cold season, near to man-made constructions and the influences of freshwater (Kovačić, 2003). It was also collected in May and September above the deeper infralittoral bottom in the northern Adriatic Sea (MK and RŠ, unpubl. data).

5) The neritic goby *Crystallogobius linearis* (Von Duben, 1845) has occasionally been caught by fishing gear in the Adriatic Sea (Kovačić, 2005 and the references therein). It has also been collected within a large school of *P. ferreri* above a sandy bottom at 12 m depth in the northern Adriatic Sea (RŠ, unpubl.data).

6) *Gobius ater* is, as explained above, a rarely recorded species and its habitat is still not well described (according to Miller, 1986: inshore lagoons, among sea grass).

A single field investigation by M. Kovačić, M. Kirinčić and D. Zanella in 2011 contributed eight new records, an increase of 44% of the previously known number of gobies in the southern Adriatic Sea (18 species, Tab. I). The results were obtained with limited collecting effort of just six SCUBA dives. A similar increase of knowledge (seven new records) with limited collecting effort was also achieved in a survey on Crete (Kovačić *et al*., 2011). Only a few better researched areas in the north-western part of the Mediterranean (Ibiza Island, Banyuls-sur-Mer) and the Adriatic Sea (Kvarner Bay) are known to have high gobiid biodiversity (Patzner and Glechner, 1992; Kovačić, 2005; Fischer *et al*., 2007; Kovačić and Patzner, 2011 and references therein). Crete, with 17 known species, could be added to this list of gobiid rich Mediterranean areas, despite the fact that only a single gobiological field survey was performed there (Kovačić *et al*., 2011). The rest of the Mediterranean is without published reports on localities with high gobiid biodiversity. The Crete field survey and the present study have shown that limited gobiological field efforts, i.e. two or three divers, 5-6 SCUBA dives with anaesthetic and a handnet, could provide an initial estimation of the gobiid biodiversity of an area, since the majority of the Mediterranean gobiid species (see the list in Kovačić and Patzner, 2011) are catchable using this technique. It is difficult to expect that appropriate data for obtaining a realistic overview on the zoogeography of Mediterranean gobies could be gathered through occasional records of gobies and by gobiid bycatches from other ichthyological or fishery surveys. Point data or data from small geographic areas collected in gobiological field surveys are necessary to ascertain whether the present differences of gobiid biodiversity among and within large Mediterranean geographic areas really exist or whether they are simply the result of poor research intensity (Kovačić and Patzner, 2011). The real pattern of the geographic distribution of Mediterranean gobiid species would indicate whether the zoogeographic areas in the Mediterranean varying in their gobiid biodiversity can be recognized and how they should be delimited. These data are also necessary to resolve the distribution of "rare" gobies in the Mediterranean. The known data suggests that the distribution of "rare" gobies in the Mediterranean is irregular and clustered, but additional information could indicate that their ranges are uniform and continuous throughout the Mediterranean or in an area within.

Acknowledgements. - Thanks go to Linda Zanella for proofreading the English. We thank Adam Petrusek for his photograph of *Thorogobius ephippiatus*. RŠ received support from the Czech Ministry of Culture (project MK00002327201) and from the SYNTHESYS Programme (project ES-TAF-1249), financed by European Community Research Infrastructure Action under the FP7 "Capacities" Programme at the Museo Nacional de Ciencias Naturales (CSIC).

REFERENCES

AHNELT H. & DORDA J., 2004. - Gobioid fishes from the north eastern Atlantic and the Mediterranean: new records and rarely found species. *Ann. Naturhist. Mus. Wien, Ser. B. Bot. Zool*., 105: 5-19.

CLARK P.U., DYKE A.S., SHAKUN J.D., CARLSON A.E., CLARK J., WOHLFARTH B., MITROVICA J.X., HOSTETLER S.W. & McCABE A.M., 2009. - The last glacial maximum. *Science, 325: 710-714.*

DEBELIUS H., 2001. - Mediterranean & Atlantic Fish Guide. 305 p. Rab: Ronilački centar Kron. [in Croatian]

DULČIĆ J. & DRAGIČEVIĆ B., 2011. - New Fishes of the Adriatic Sea and the Mediterranean Sea. 160 p. Split, Zagreb: Institute for Oceanography and Fisheries Split, State Institute for Nature Protection. [in Croatian]

DULČIĆ J., GRBEC B. & LIPEJ L., 1999. - Information on the Adriatic ichthyofauna – Effect of water warming? *Acta Adriat*., 40: 33-43.

FISCHER S.T., PATZNER R.A., MÜLLER C.H.G. & WINKLER H.M., 2007. - Studies on the ichthyofauna of the coastal waters of Ibiza (Balearic Islands, Spain). *Rostocker Meeresbiol. Beitr*., 18: 30-62.

FRANCOUR P., 2008. - First records of *Didogobius splechtnai* along French Mediterranean coast and additional comments about *D. schlieweni*. *Acta Ichthyol. Piscatoria*, 38: 139-141.

GUIDETTI P., BUSSOTTI S. & KOVAČIĆ M., 2006. - First record of the large-scaled goby, *Thorogobius macrolepis* (Pisces, Gobiidae), in Italian Seas. *Thalassia Salentina*, 29: 41-45.

JARDAS I., 1996. - Adriatic Ichthyofauna. 533 p. Zagreba: Školska knjiga. [in Croatian]

KOVAČIĆ M., 2003. - Hyperbenthic gobies in the Kvarner area, Adriatic Sea. *J. Fish Biol*., 63: 1051-1055.

KOVAČIĆ M., 2005. - An annotated checklist of the family Gobiidae in the Adriatic Sea. *Ann. Istrian Medit. Stud., Ser. Hist. Nat*., 15: 1-24.

KOVAČIĆ M., 2008. - The key for identification of Gobiidae (Pisces: Perciformes) in the Adriatic Sea. *Acta Adriat.*, 49: 245-254.

KOVAČIĆ M. & GOLANI D., 2007. - First record of three gobiid species in the Levant. *Cybium*, 31: 89-91.

KOVAČIĆ M. & ENGIN S., 2009. - First record of the zebra goby, *Zebrus zebrus* (Gobiidae), in the Black Sea. *Cybium*, 33: 83-84.

KOVAČIĆ M. & PATZNER R.A., 2009. - Reidentification of *Buenia* specimens (Gobiidae) from Banyuls-sur-Mer (France, western Mediterranean). *Cybium*, 33: 175-176.

KOVAČIĆ M. & PATZNER R.A., 2011. - North-Eastern Atlantic and Mediterranean Gobies. *In:* The Biology of Gobies (Patzner R.A., Van Tassell J.L., Kovačić M. & Kapoor B.G., eds), pp. 177-206. New York: Science Publishers, CRC Press, Taylor & Francis Group.

KOVAČIĆ M., MILETIĆ M. & PAPAGEORGIOU N., 2011. - A first checklist of gobies from Crete with ten new records. *Cybium,* 35: 245-253.

LIPEJ L. & DULČIĆ J., 2010. - Checklist of the Adriatic Sea fishes. *Zootaxa,* 2589: 1-92.

LIU H.T.H., AHNELT H., BALMA G.A.C. & DELMASTRO G.B., 2009. - First record of *Gobius roulei* (Gobiidae) in the Ligurian Sea. *Cybium,* 33: 253-254.

MILLER P.J., 1986. - Gobiidae. *In*: Fishes of the North-eastern Atlantic and the Mediterranean, Vol. III (Whitehead P.J.P., Bauchot M.-L., Hureau J.C., Nielsen J. & Tortonese E., eds), pp. 1019-1085. Paris: Unesco.

MILLER P.J., 1988. - New species of *Corcyrogobius*, *Thorogobius* and *Wheelerigobius* from West Africa (Teleostei: Gobiidae). *J. Nat. Hist.*, 22: 1245-1262.

NELSON J.S., 2006. - Fishes of the World. 4th edit., 601 p. Hoboken, New Jersey: John Wiley & Sons.

PATZNER R.A. & GLECHNER R., 1992. - Die Litoralfische von Banyuls. *Bufus-Info*, *Univ. Salzburg,* 11: 51-60.

PÉRÈS J.M. & GAMULIN-BRIDA H., 1973. - Biological oceanography: Benthos. Benthic Bionomy of the Adriatic Sea. 493 p. Zagreba: Školska knjiga. [in Croatian]

ŠANDA R. & KOVAČIĆ M., 2009. - First record of *Gobius couchi* (Gobiidae) in the Ionian Sea. *Cybium*, 33: 249-250.

SANZO L., 1911. - Distribuzione delle papille cutanee (organi ciatiforme) esuo valore sistematico nei Gobi. *Mitt. Zool. Stn. Neapel*, 20: 249-328.

STEFANNI S., 2000. - First record of the Norway goby in the Adriatic Sea. *J. Fish Biol.*, 57: 828-830.

SCHULTZ G., 1975. - Beobachtungen über Vorkommen und Lebensweise von *Thorogobius ephippiatus* (Lowe, 1839) (Pisces) in der Nord- und Mitteladria. *Ann. Naturhist. Mus. Wien,* 79: 183-192.

VANHOVE M.P.M, KOVAČIĆ M., KOUTSIKOS N.E., ZOGARIS S., VARDAKAS L.E., HUYSE T. & ECONOMOU A.N., 2011. - First record of a landlocked population of marine *Millerigobius macrocephalus* (Perciformes: Gobiidae): observations from a unique spring-fed karstic lake (Lake Vouliagmeni, Greece) and phylogenetic positioning. *Zool. Anz.,* 250: 195-204.

Reçu le 10 mai 2012.
Accepté pour publication le 12 juillet 2012.